Chapter 11
RNST:
Precise Localization Based on Trilateration for Indoor Sensor Networks

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ABSTRACT

The key problem of location service in indoor sensor networks is to quickly and precisely acquire the position information of mobile nodes. Due to resource limitation of the sensor nodes, some of the traditional positioning algorithms, such as Two-Phase Positioning (TPP) algorithm, are too complicated to be implemented and they can not provide the real-time localization of the mobile node. We analyze the localization error, which is produced when one tries to estimate the mobile node using trilateration method in the localization process. We draw the conclusion that the localization error is the least when three reference nodes form an equilateral triangle. Therefore, we improve the TPP algorithm and propose Reference Node Selection algorithm based on Trilateration (RNST), which can provide real-time localization service for the mobile nodes. Our proposed algorithm is verified by the simulation experiment. Based on the analysis of the acquired data and comparison with that of the TPP algorithm, we conclude that our algorithm can meet real-time localization requirement of the mobile nodes in an indoor environment, and make the localization error less than that of the traditional algorithm; therefore our proposed algorithm can effectively solve the real-time localization problem of the mobile nodes in indoor sensor networks.

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INTRODUCTION

Wireless Sensor Networks (WSNs) have been attracting increasing research interest given the recent advances in miniaturization, low-cost and low-power design. WSNs hold the promise of many new applications in the area of monitoring and control. Spatial localization (determining physical location) of a sensor node is an example of critical service for context-aware applications in WSNs. Examples include target tracking, intrusion detection, wildlife habitat monitoring, climate control, and disaster management (Fengyuan Ren, Haining Huang & Chuang Lin, 2003). Most of the applications are related to the positions of sensor nodes: sensing data without the position information of the sensor nodes are not useful, thus self-localization is the basic application in a WSN (Fubao Wang, Long Shi & Fengyuan Ren, 2005). Sensor nodes often need to determine their further actions based on their physical locations. To precisely obtain the position information of a mobile node is the key of the location service, therefore how to efficiently and precisely acquire the mobile nodes' position information, and being able to provide the location service to the user, is one of the important problems in WSNs.

In an indoor environment, one of the major challenges for researchers is to localize the sensor nodes with relatively high localization precision. For military radio networks, knowing the precise location of each person with a radio can be critical. In offices and in warehouses, object localization and tracking applications are possible with large-scale ad-hoc networks of wireless tags. Existing geo-location systems such as GPS do not always meet the operational (e.g. power), environmental (e.g. indoors) or cost constraints in indoor sensor networks. It is also impractical to configure the position information for every node in an indoor environment. Therefore, reference nodes with their positions are vital aspects of nearly every localization system; the mobile nodes get their own positions based on the position information of reference nodes using localization techniques, including RSSI, AoA, ToA/TDoA, etc. In the past few years, a number of positioning algorithms have been proposed to reduce the localization error of the mobile nodes. Many researches dealt with the node localization issues without taking into account the freference node" parameter, however reference node placement also strongly affects the quality of spatial localization (N. Bulusu, et al., 2001; N. Bulusu, et al., 2003).

In this chapter, we analyze the localization error, which is produced when one tries to estimate the mobile node using trilateration method in the localization process. We draw the conclusion that the localization error is the least when three reference nodes form an equilateral triangle. Our analysis provides theoretical foundation for purposefully selecting the suitable reference nodes to reduce the localization error in indoor sensor networks. We improve the TPP algorithm and propose a novel RNST positioning algorithm, which can satisfy the real-time localization requirement of the mobile nodes. We also implement our proposed RNST algorithm using the network simulator OPNET and actual Zigbee sensor platform, and make a comparison with the TPP algorithm. The experimental results show that our algorithm can effectively meet real-time localization requirement of the mobile nodes with limited resources. Moreover our algorithm can also guarantee the minimum localization error within a short time period and effectively meet the localization precision requirement of the mobile nodes. Compared to the existing approaches, RNST algorithm is able to quickly estimate the position of the mobile node based on the received packets. To the best of our knowledge, this is the first comprehensive work on reference node selection algorithm based on trilateration.

This chapter is organized as follows. In Section 2, we list the related work in more details. In Section 3, we present the theoretical background of our proposed RNST algorithm. We present our RNST algorithm and analyze the reasons of the

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